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The Marine Laboratory Four-Panel Trawl

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Introduction

In the course of fishing gear investigations the Laboratory carries out detailed studies on the design, construction and performance of both traditional and experimental trawls. Early in 1973 a series of trawl engineering performance trials took place on FRV "Scotia", a 1300 hp stern ramp distant-water research trawler (Wileman, Galbraith & Foster, 1974). Two of the nets tested, the Granton and 96' Stella trawls, were established commercial gears while the other two nets, the 119' Stella and White Sea trawls, were experimental gears designed to afford enhanced fishing capacity by virtue of increased mouth openings. The Stella trawls were enlarged Granton two-panel nets, with widened fishing squares and extended top wings. The White Sea Trawl, so called because the original fishing trials took place off the North Cape of Norway, was of four-panel construction. It was an improved version of a previous Laboratory four-panel trawl, a polypropylene net known as the Large Mesh Bottom Trawl, originally designed as a wide-spreading gear.

Of the four nets tested the White Sea gear appeared to offer the greatest potential for improvement. It was felt that a four-panel design could best be utilised to produce an improved high headline, hard-ground bottom trawl, although it was recognised that further experimental work at this scale would be expensive. A smaller version of the gear was designed, therefore, for use on FRV "Mara", a 200 hp side trawler, where diving observation and measurement techniques on seine net gear had already been well established (Hemmings, 1971, 1973). Investigations into the influence of hanging ratios, cutting rates, mesh and twine sizes were being conducted on "Mara" at that time using similar diving and instrumentation techniques and this work was extended to include studies on the scaled-down White Sea trawl.

Design Objectives

There had been for some time a requirement in the fishing industry for a high-headline, hard-ground bottom trawl — a net capable of being used on any grounds worked with traditional bobbin trawls, but with increased fishing capacity from the improved mouth opening. With gear and fuel prices constantly increasing, it was imperative that manufacturing and operating costs should be competitive and that the net should be capable of operation by existing vessels employing conventional gear handling systems.

Therefore, the principal design objectives for the proposed trawl were

1. Increased headline height, whilst maintaining wing-end spread.
2. No increase in drag.
3. Reduction in vulnerability to ground damage.
4. Ease of handling, with minimum modification to existing systems.
5. Competitive manufacturing costs.

Experimental Methods

The initial work was carried out on FRV "Mara" off Lossiemouth in water depths of 18-22 m. This area had been used in previous years for diving observations on the seine net and the bottom was for the most part sand or gravel. Adjacent areas of "patchy" ground consisting of rocks and boulders provided a convenient location for diving observations on the performance of the trawl on hard ground.

At first, techniques similar to those used on the seine net were employed, ie free swimming divers using still and cine cameras with back-pack tape recorders, but with the development of diver-operated low-light television from a towed wet vehicle direct observations from the ship became possible (Main & Sangster, 1976, 1978a & b). This technique proved particularly valuable in monitoring the effects of tailoring and rigging changes. Subsequently, the development of a remote-controlled television vehicle capable of working in much deeper water was a further important advance in observation technique (Wardle & Priestley, 1976). These observations were supplemented by underwater and shipboard instrumentation, measuring such gear parameters as heights, spreads, drags and speed (Urquhart, 1981).

Throughout the trials a twin-bridle rig (Fig. 1) was employed to allow unrestricted vertical opening, with bridles of 27.5 m (15 fm) minimum length giving a satisfactory gape. The warp length used was 137 m (75 fm). The original scaled-down net (Fig. 2(a)) was fished with 1.63 m flat wooden doors and first observations showed several design faults. The greatest areas of distortion and stress were in the square and top gussets. After several unsuccessful attempts at rehanging the square and gussets the problem was to a great extent alleviated by cutting back the square to a depth of 60 rows (Fig. 2(b)). This net, known as the Lossie A, was further improved by decreasing the number of bosom meshes and shaping the gussets to produce the Lossie B, or standard net (Fig. 3). This sequence of nets became known as "Lossie Trawls" because of the proximity of Lossiemouth to the test area.

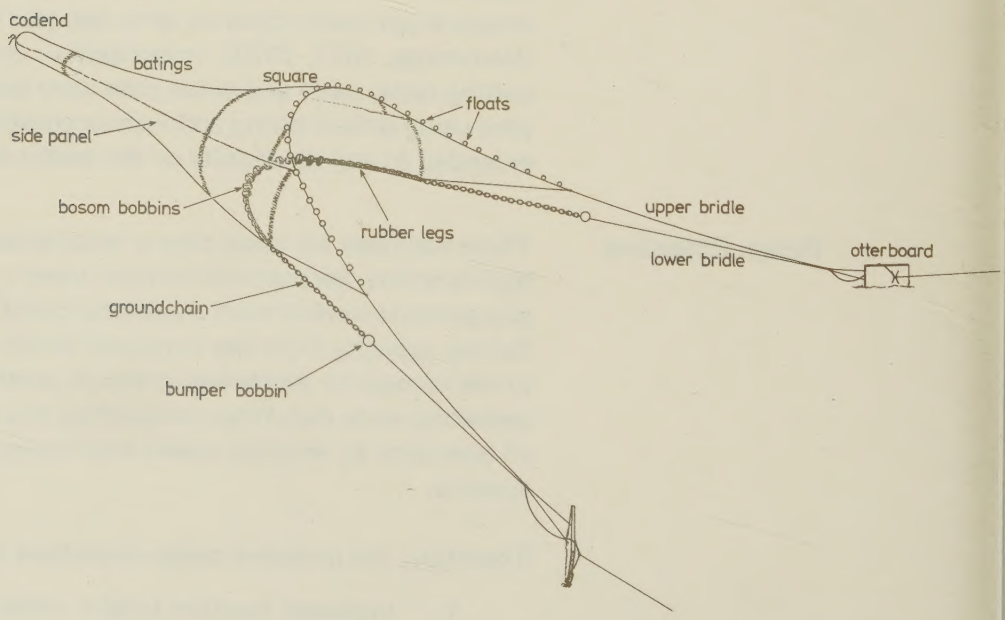


Figure 1. Twin-bridle rig for four-panel trawl.

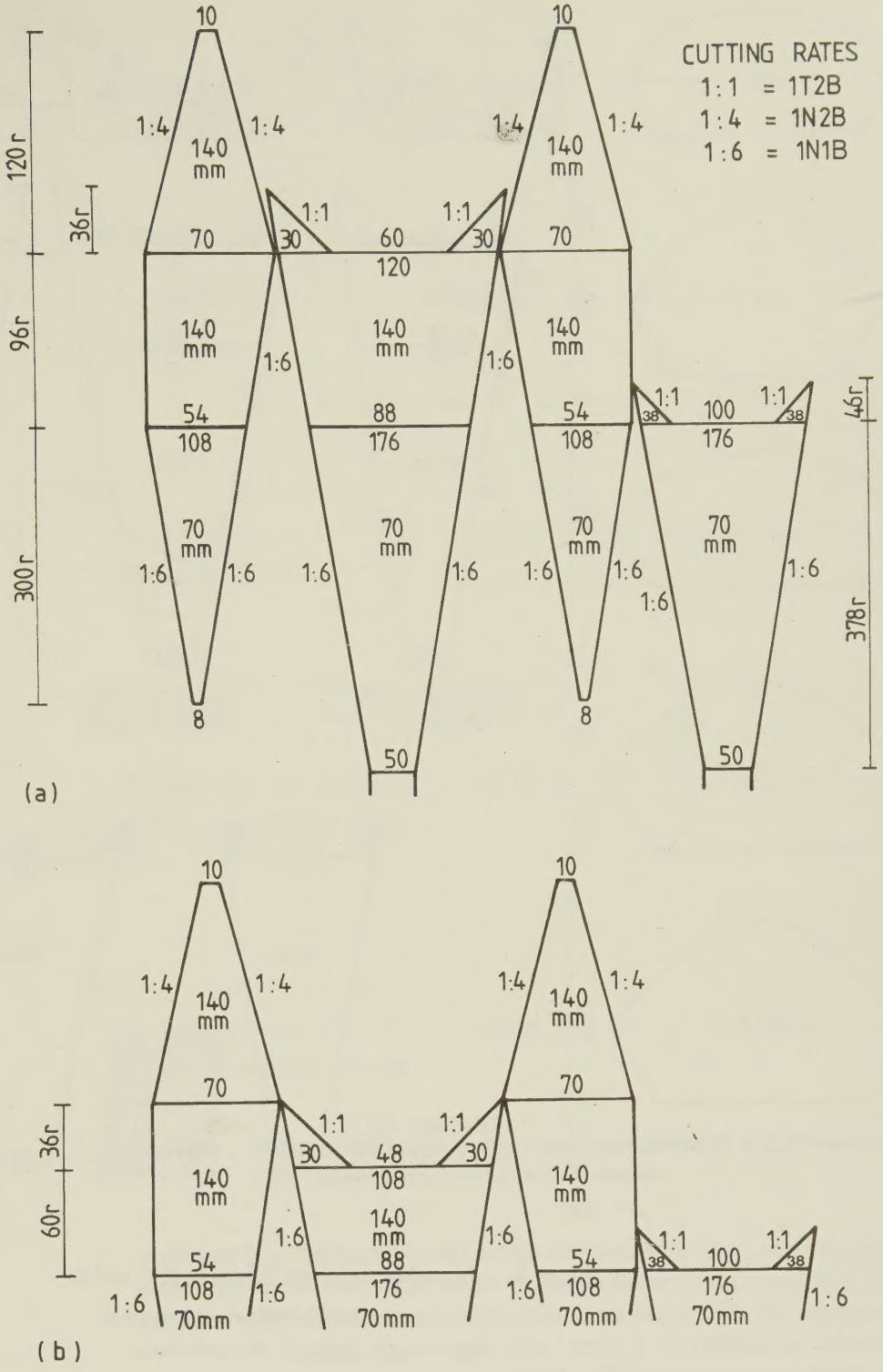


Figure 2. (a) Scaled-down White Sea Trawl (200 hp);

(b) Lossie A Trawl, as White Sea Trawl but with cut back square.

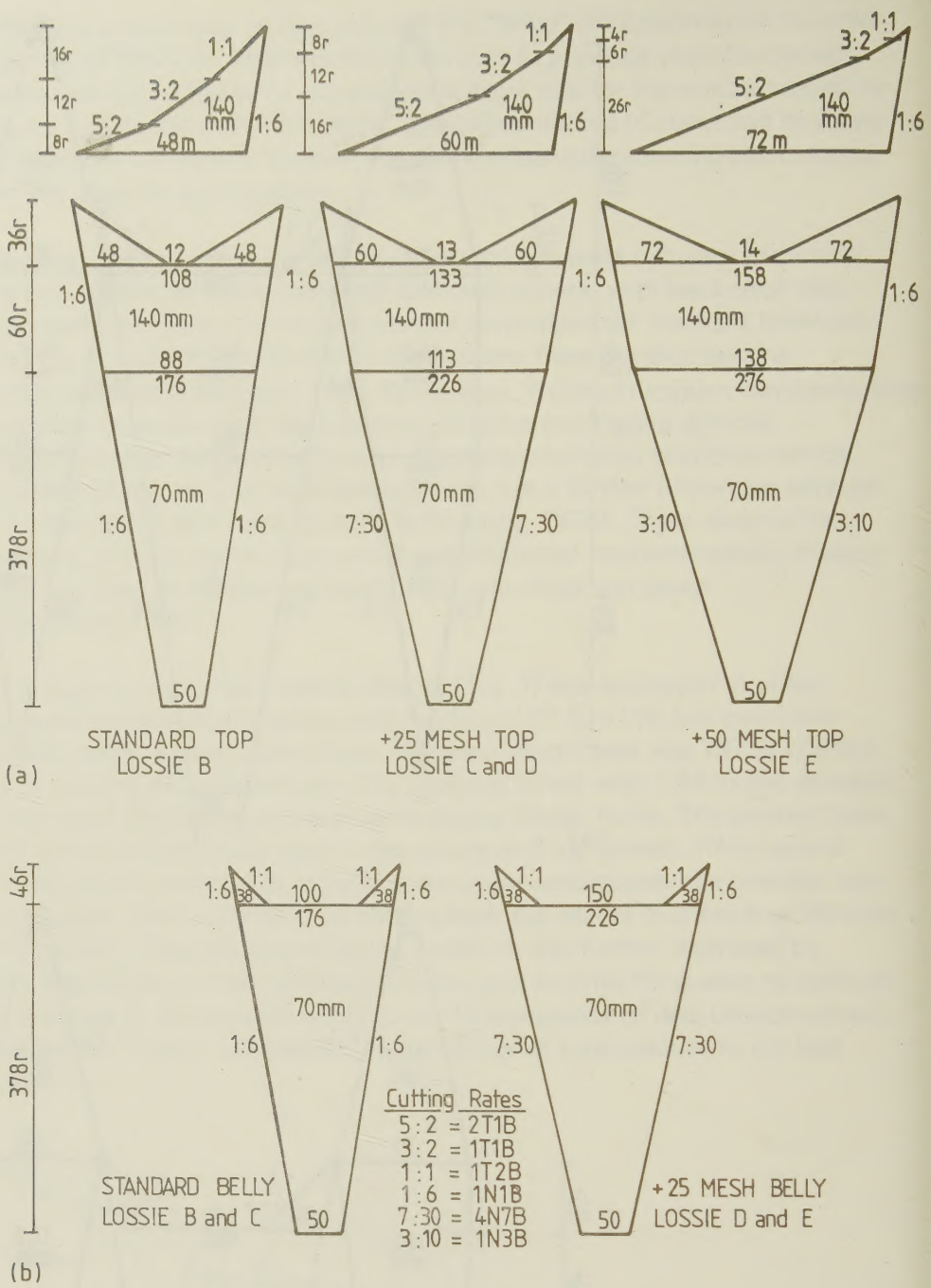


Figure 3. Experimental Lossie Trawls B, C, D and E:

(a) upper panels with shaped gussets;

(b) lower panels.

The standard net appeared to be lacking in width, however, with the belly netting too close to the bottom. Widened top and bottom panels were made up, similar in length to the standard panels, but cut steeper in order to lift the belly clear of ground damage. Two upper panels were used, one widened by 25 meshes (at 140 mm mesh size equivalent) and one by 50 meshes with bating rates of 7:30 and 3:10, respectively (Fig. 3(a)). Similarly, a lower panel widened by 25 meshes (at 140 mm mesh equivalent) with a bating rate of 7:30 was also tried (Fig. 3(b)). The net mouth geometry attained by the various combinations was drawn up from divers' and instrument measurements (Fig. 4). The flat otterboards were not large enough to spread the Lossie C gear properly and were replaced by more efficient 1.63 m steel cambered doors, which were also used with the Lossie D and E gears.

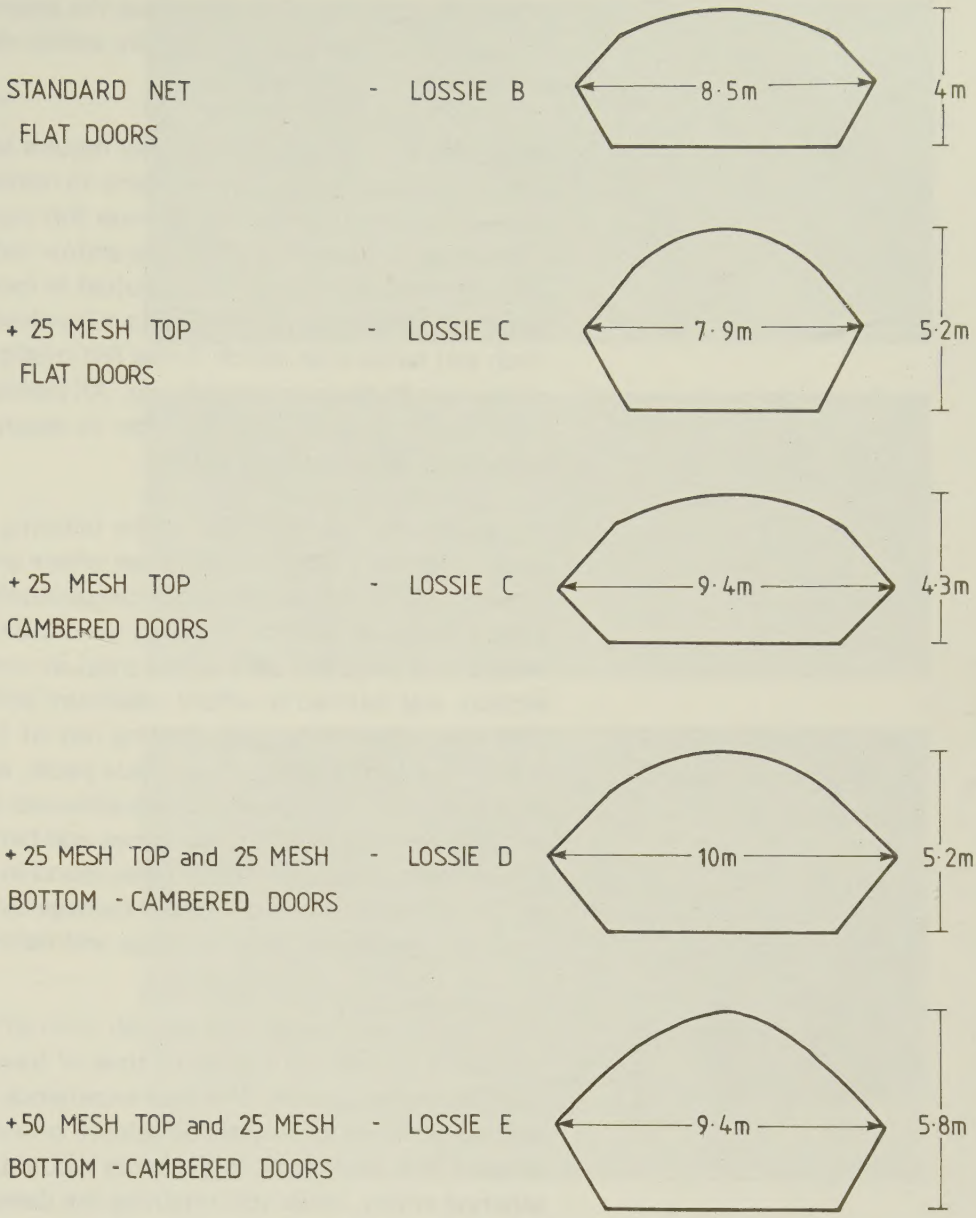


Figure 4. Experimental Lossie Trawls: net mouth geometry at 2.75 knots — effects of widening top and bottom panels.

Although the "balloon" type combination such as the Lossie C and Lossie E, where the upper panel was wider than the lower, did provide increased headline height, considerable distortion was evident in the top panel and elsewhere in the net. In contrast, the Lossie D combination, where both top and bottom panels were widened by 25 meshes, proved to be much more satisfactory. Besides furnishing an acceptable headline height and wing-end spread this arrangement gave a well balanced gear with minimal distortion and good rough ground potential. Subsequent trials were carried out with different mesh and twine sizes, modified side panels and wings cut back even further, but the basic concept of the Lossie D (or Lossie J as the commercial version of this net became known) was the foundation on which the later series of trawls was built.

Design Notes

One of the basic design concepts behind the Marine Laboratory Four-Panel Trawl was that the strain paths in the net should, as far as possible, follow the framing lines and selvedges, so allowing unrestricted opening of the netting panels. All framing rope lengths and, where applicable, selvedge line lengths were calculated on the basis of the netting being hung "by the half", ie mesh openings of 50%; although each panel did not open quite to this

extent, this method did ensure that the strain was taken on the ropes, so freeing the netting to open laterally within the constraints imposed by drag upon the netting itself.

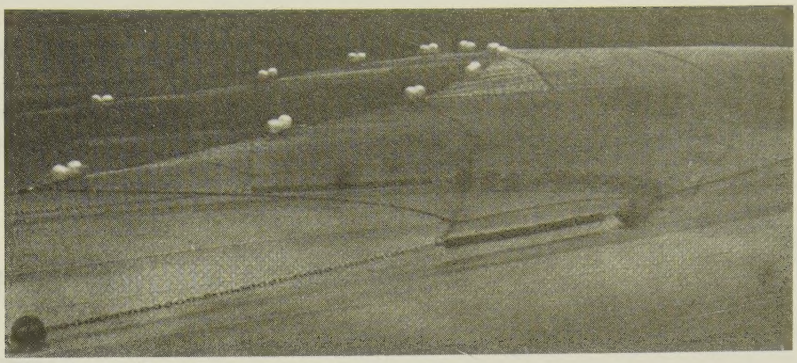
Large opening trawls automatically require larger netting areas and this in turn increases drag, so that economy in netting area had to be achieved by careful tailoring in order to minimise this increase. The traditional alternative, ie increasing mesh size and/or reducing twine size, was unacceptable as it would have resulted in increased vulnerability to ground damage. Furthermore, it would have involved the use of "non-standard" mesh and twine sizes which it was felt might well reduce the attractiveness of the gear to the commercial user. All panels were laced length for length, ie no slack between panels, in order to secure a maximum of netting area cover with a minimum of netting.

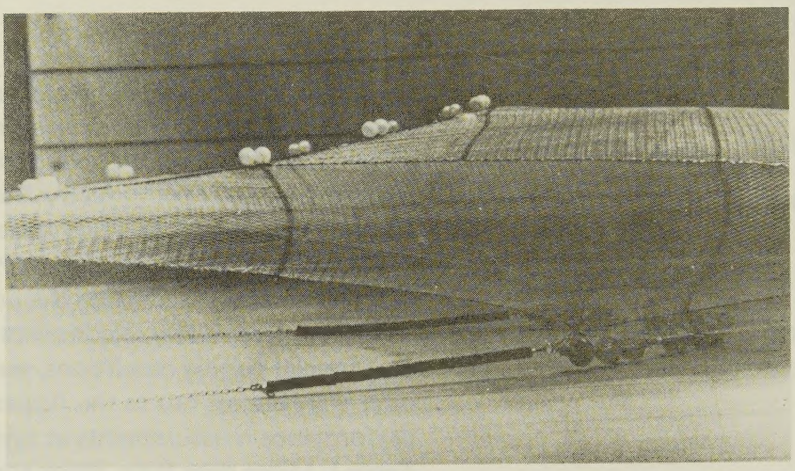
Particular attention was paid to the tailoring of the first belly/lower side panel area, the underside of the net where ground damage is most likely. In a four-panel net the wing/side panel usually rises more or less vertically from the ground gear by virtue of the construction, so it was important to ensure that the other part of the trawl in contact with the bottom, the belly section, was tailored to afford maximum protection from ground damage. This was achieved by using a bating rate of 1:4 or steeper in the belly and 1:6 on the corresponding lower side panel, so that the belly netting streamed gradually upwards and backwards from the bobbins, leaving the entire lower mouth of the net above and behind the protection of the ground gear (Plate I(a), (b)). It was found in practice that even rougher ground could be worked without damage by flying the lower wing from the bunt, where the lower selvedge and fishing line meet (Plate I(c)).

Gear Development

With the general design and over-all form of the gear established it was necessary to draw up a range of sizes of trawls suitable for vessels of various towing powers. Previous experience had shown that simply scaling a gear up or down in proportion seldom proved successful, so it was decided that each trawl in the series would be developed independently as a separate entity, while still retaining the design characteristics of the range as a whole. The original intention had been to concentrate on an improved distant water gear but the changing composition of the fishing fleet meant that near water and inshore vessels had also to be taken into consideration, with boats down to 50 hp undertaking hard-ground bottom trawling.

The considerable task of establishing a new series of trawls suitable for vessels from 50 to 2000 hp was aided in no small manner by the goodwill and generosity of the fishermen of the North-East of Scotland and other parts of the UK. It was recognised from the start that, in addition to basic design and engineering work, the successful development of these trawls would entail a continual evaluation of their fishing capabilities. Previous comparative fishing exercises had proved expensive and often inconclusive, so an alternative policy of directly involving the commercial fleet on a voluntary basis was followed. Skippers from Aberdeen and neighbouring ports interested in the new gear were supplied with prototype nets for commercial evaluation. At first Laboratory advisers sailed with the vessels but, as development progressed, the skippers worked the gear on their own and reported back at the end of each trip. Many of the criticisms and suggestions made by these fishermen, who gave freely of their time, effort and expertise, were incorporated into the net designs and associated rigging. As the range of trawls increased the Industrial Development Unit of the Sea Fish Industry Authority (Formerly White Fish Authority) also became involved in the introduction of the four-panel gear to other parts of the country (Corrigall & Watson, 1977).





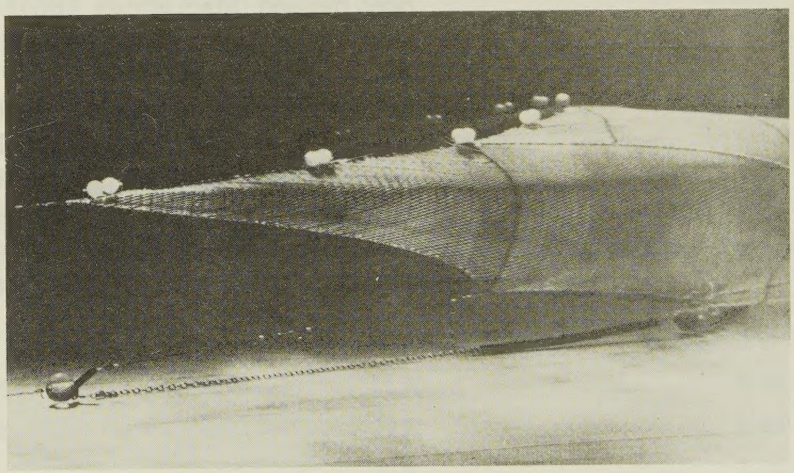


Plate I. 600 hp North Sea Trawl (1:10 scale model) in S.F.I.A. Flume Tank, Hull:

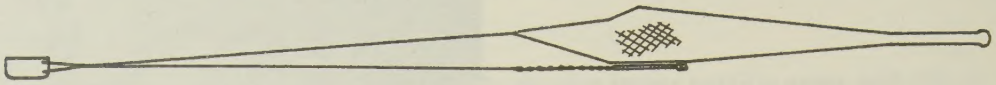
(a) standard rig A, showing lower netting well clear of bottom;

(b) standard rig A, close up of net mouth;

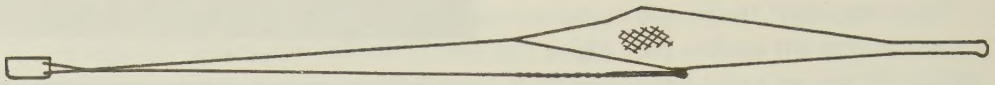
(c) rig B, flying wings;

(d) rig C, dan leno bobbin and triangle (see also Fig. 5).

a) Twin-bridle rig with wings battened down



b) Twin-bridle rig with wings flying



c) Twin-bridle rig with dan leno bobbin and triangle

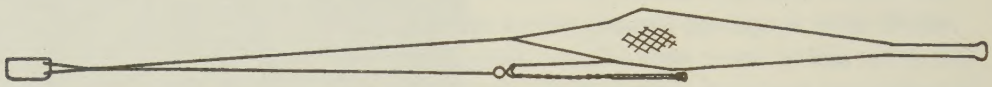


Figure 5. Twin-bridle rig: alternative rigging arrangements (see also Plate I).

In parallel with this commercial assessment, design and engineering studies were carried out on the Laboratory's research fleet as the series was extended to cover all the required categories of vessels. Extensive use was made of the Sea Fish Industry Authority (formerly White Fish Authority) Flume Tank in Hull to study scale models of the larger trawls (White Fish Authority Industrial Development Unit, 1981), while full scale inshore gears were scrutinised using the underwater television techniques already described. Eventually, a complete range of trawls, tried and tested under commercial fishing conditions, was drawn up. Detailed specifications of all nine gears are set out in the Appendix. Results from engineering performance measurements at typical towing speeds are summarised in Table I. Using data from these engineering trials an empirical formula has been devised (MacLennan, 1981) to predict net drag. This formula is given in Table II with data for the nine trawls.

Polyethylene twine was used in all versions of the trawl. Mesh and twine sizes were, for the most part, similar to those in common use in the fisheries for which each net was designed. The nets were named on this basis, with the distant and middle water versions known as the White Sea and Faroe trawls, the near water gears as North Sea Trawls, and the inshore nets as Lossie trawls, for reasons already explained.

Table I. Marine Laboratory Four-Panel Trawls — Some Engineering Performance Parameters

Net Reference Number	Trawl	Towing Speed (Knots)	Headline Height (m)	Board Spread (m)	Wing-end Spread (m)	Bridle Angle (Degrees)	Net Drag (t)	Gear Drag (t)	Gear hp
BT 124R	Lossie Trawl (50-100 hp)	2.75	2.75	20.7	9.1	11.4	0.64	0.81	15
BT 124Q	Lossie Trawl (100-200 hp)	2.75	4.0	28.0	10.1	9.1	0.93	1.35	25
BT 124J	Lossie Trawl (250-400 hp)	2.75	4.4	22.9	12.2	10.5	1.27	1.70	32
BT 130D	Faroe Trawl (600 hp)	3.0	3.1	58.2	—	—	2.15	3.62	73
BT 130C	North Sea Trawl (600 hp)	3.0	4.6	43.9	15.2	14.3	2.29	3.63	74
BT 130B	North Sea Trawl (800 hp)	3.0	5.2	45.7	15.5	15.1	2.84	4.78	97
BT 130E	North Sea Trawl (1000-1500 hp)	3.0	4.5	69.2	24.0	15.2	4.13	5.85	119
	"	4.0	4.0	68.6	24.7	14.7	6.08	8.02	217
BT 134	White Sea Trawl (1000-1500 hp)	3.0	5.6	77.7	26.1	17.4	3.87	5.60	114
	"	4.0	5.0	75.6	25.3	16.9	5.81	7.74	210
BT 135	White Sea Trawl (2000 hp)	3.0	8.1	73.2	26.7	15.6	5.59	7.51	153
	"	4.0	7.2	72.0	27.6	14.9	8.25	10.34	280

Table II. Twine Area and Predicted Net Drag (after MacLennan, 1981)

$$D = R\,[61.2 + 46.6\,V^2/(1 + 0.0641\,V)]/9807$$

where D = drag (t)
R = twine area (m^2)
V = speed (knots)

This formula enables the drag of a four-panel trawl of similar design but different size to be estimated. For calculation of twine area, see Ferro (1981).

Net Reference Number	Twine Area (m^2)	Drag (t) at 3 knots
BT 124R	11.6	0.49
BT 124Q	23.5	0.99
BT 124J	30.8	1.30
BT 130D	40.5	1.71
BT 130C	48.9	2.06
BT 130B	55.6	2.34
BT 130E	97.9	4.12
BT 134	99.1	4.17
BT 135	123.1	5.18

Gear Operation

The four-panel trawl is shot and hauled in the same manner as any other bottom trawl, with the same otterboards, ground gear, floats and other hardware. The all-metal "Vee"-type otterboards favoured by the inshore fleet are used with the smaller nets, while the near and middle distance gears are generally used with rectangular flat wooden doors. The largest nets are fished with polyvalent doors. The only significant variation from the more traditional gear arrangements are the various twin-bridle rigs (Fig. 5). Rig C was evolved in order to work over broken and uneven ground such as sandbanks where good ground contact is required to follow the contours, while at the same time keeping the wing netting clear of the bottom (Plate I(d)). With rigs A and B headline height can be increased and bottom contact lessened by lengthening the upper bridle, while lengthening the lower bridle has the opposite effect. The lower bridle is frequently extended when fishing species such as cod hard on the bottom, although the net is more prone to ground damage in this condition.

Although with equal bridles the four-panel gear tends to tow on the headline, almost every complaint about the net "not fishing" could be traced to the gear being off the bottom, mainly due to insufficient groundrope weighting. To counteract this, drilled steel bobbins were added to the groundrope at strategic points where observations had indicated uplift was greatest. These were at the quarters, at the end of the bunt section where the lower selvedge runs out, and below the wing line/fishing line junction. On the smaller gears short lengths of chain wrapped round the footrope at these points served the same purposes. While light bottom-contact has obvious advantages for hard-ground work, there is a reduction in fishing capability when the gear is not taking the bottom properly.

Summary

The development of a range of high-headline hard-ground bottom trawls suitable for vessels from 50 to 2000 hp is described. Detailed specifications are set out in an Appendix. All nets performed satisfactorily in extensive commercial fishing trials.

Reports from fishermen using these gears have been unequivocally favourable. Many feel that increased catch-rates, particularly of roundfish such as haddock and whiting when off the bottom, are realised with the higher headline. Virtually all report a marked improvement in rough-ground work, and an enhanced ability to fish much harder areas with these trawls.

Manufacturing costs for the nets do not differ significantly from those for a comparable conventional trawl, and many skippers believe the four-panel gear to be considerably more cost-effective, owing to time and material saved by lower incidence of ground damage. A number of UK net-making firms manufacture the trawls for both domestic and overseas markets.

One of the mostly widely used of the nets in this series, the 600 hp North Sea Trawl (Net Reference Number BT 130C) features in the 1978 FAO Catalogue of Fishing Gear Designs. The distant water versions of the gear have been fished successfully not only in Northern Europe, but in places as far apart as Greenland and South Australia.

Acknowledgements

It is not possible to list all those in the Laboratory and in the Fishing Industry who contributed to this project but mention should be made of the following:— former colleagues Alisdair Corrigall (originator and project leader), Dave Wileman and Eric Wright; W.K.T. Gray and netstore staff; the Laboratory diving team, especially Dr C.C. Hemmings, J. Main, G.I. Sangster and A. Tough; A. MacDonald and W.R. Leys for instrumentation support; R. Priestley and television staff; the officers and men of FRV "Scotia", "Explorer", "Clupea" and "Goldseeker" and in particular the late Bill "Skatie" Mair and crew of FRV "Mara"; Skippers R. Kluzniak ("Scottish Princess"), J. Bowman, Jnr. ("Strathdon", "Grampian Eagle"), I. Smith ("Arctic Hunter"), J. Bowman, Snr. ("Grampian Cairn"), J. Gowie ("Ben Asdale"), J. Slater ("Arnisdale"), E. Simpson ("Aquila"), A. Simpson ("Strathclova"), R. Foster ("Picton Sea Eagle"), P. Smith ("Maranatha"), W. Wilson ("Deeside"), B. Strachan ("Brothers Too"), L. Gibson ("Mari-Dor"), T. Taylor ("Maureen June"), J. Farquhar ("Canopus"), R. Rawcliffe ("Boston Blenheim"), J. Banks ("David Wilson"); and staff of the Sea Fish Industry Authority (formerly White Fish Authority) Flume Tank and Industrial Development Unit. Thanks are also due to Mrs M. Gammie for assistance with diagrams and illustrations.

References

Corrigall, A. and Watson, C.E.P. 1977. Introduction of the Marine Laboratory Laboratory designed 4-panel bottom trawl to the British distant water and inshore fishing industry. *White Fish Authority, Research and Development Technical Report* (151), 11pp.

Ferro, R.S.T. 1981. The calculation of the twine area of a trawl net. *Scottish Fisheries Information Pamphlet* (5), 6pp.

Hemmings, C.C. 1971. Diving in relation to fish behaviour problems. Roberts, D.G. ed. *Diving applications in marine sciences. Research seminar.* National Institute of Oceanography, Seminar Series (1), 48-67. Mimeo.

Hemmings, C.C. 1973. Direct observations of the behaviour of fish in relation to fishing gear. *Helgolander Wissenschaftliche Untersuchungen,* **24,** 348-360.

MacLennan, D.N. 1981. The drag of four-panel demersal trawls. *Fisheries Research,* 1, 23-33.

MacLennan, D.N. and Galbraith, R.D. 1979. Performance tests on large four-panel trawls and polyvalent doors. *Marine Laboratory Aberdeen Working Paper* (79/6).

Main, J. and Sangster, G.I. 1976. The Aberdeen gear diving technique. *ICES CM 1976,* Document B:20, 9pp. Mimeo.

Main, J. and Sangster, G.I. 1978a. A new method for observing fishing gear using a towed wet submersible. *J.C. Gamble and R.A. York, eds. Progress in underwater science. Report of the Underwater Association,* (N.S.) (3), 259-267.

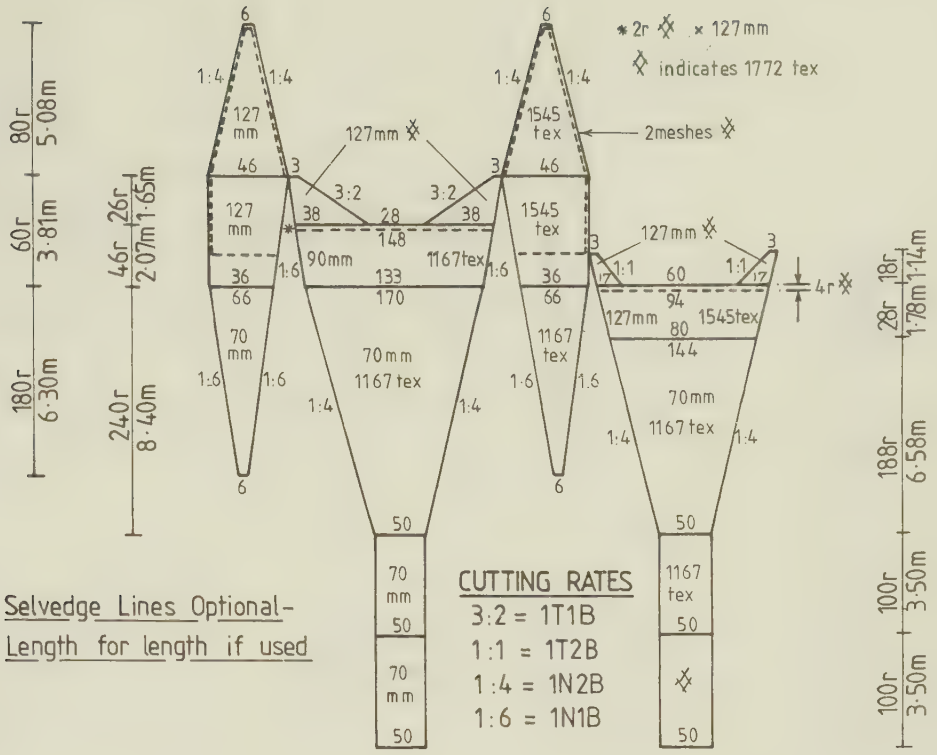
Main, J. and Sangster, G.I. 1978b. The value of direct observation techniques by divers in fishing gear research. *Scottish Fisheries Research Report* (12), 15pp.

Urquhart, G. 1981. Fishing gear instrumentation. Electronics for Ocean Technology, Birmingham, 8-10 September 1981. *Proceedings No. 51 of the Institution of Electronic and Radio Engineers,* pp. 337-348. London, Institution of Electronic and Radio Engineers.

Wardle, C.S. and Priestley, R. 1976. The basic principles of closed circuit television systems for laboratory and field use in fisheries research. *ICES CM 1976,* Document B:21, 8pp. Mimeo.

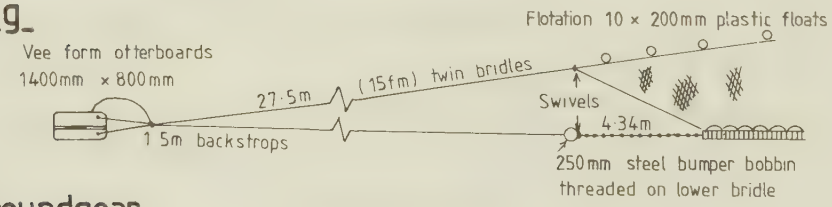
White Fish Authority Industrial Development Unit. 1981. Marine Laboratory North Sea Trawl. Data from scale model tests in the W.F.A. Flume Tank. Data sheet No. 208.

Wileman, D.A., Galbraith, R.D. and Foster, J.F. 1974. The engineering performance of demersal trawling gear. Report on trials aboard RV "Scotia", January/February, 1973. *Marine Laboratory Aberdeen Internal Report* (IR 74-5).

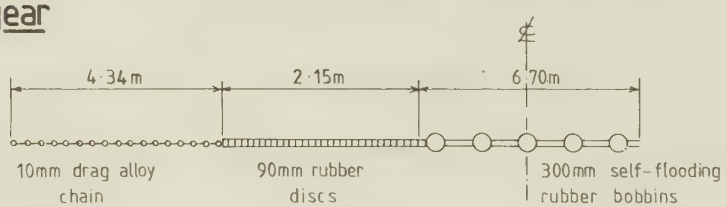


Headline - - - - 16·47m (4·57+2·75+1·83+2·75+4·57) × 12mm terylene
Groundrope - - - 11m (2·15+6·70+2·15) see below
Fishing Lines - - 11·43m (2·29+1·52+3·81+1·52+2·29) × 12mm terylene
Winglines - - - - 4·57m × 12mm terylene
Groundchain - - 4·34m × 10mm drag alloy chain

Rig



Groundgear

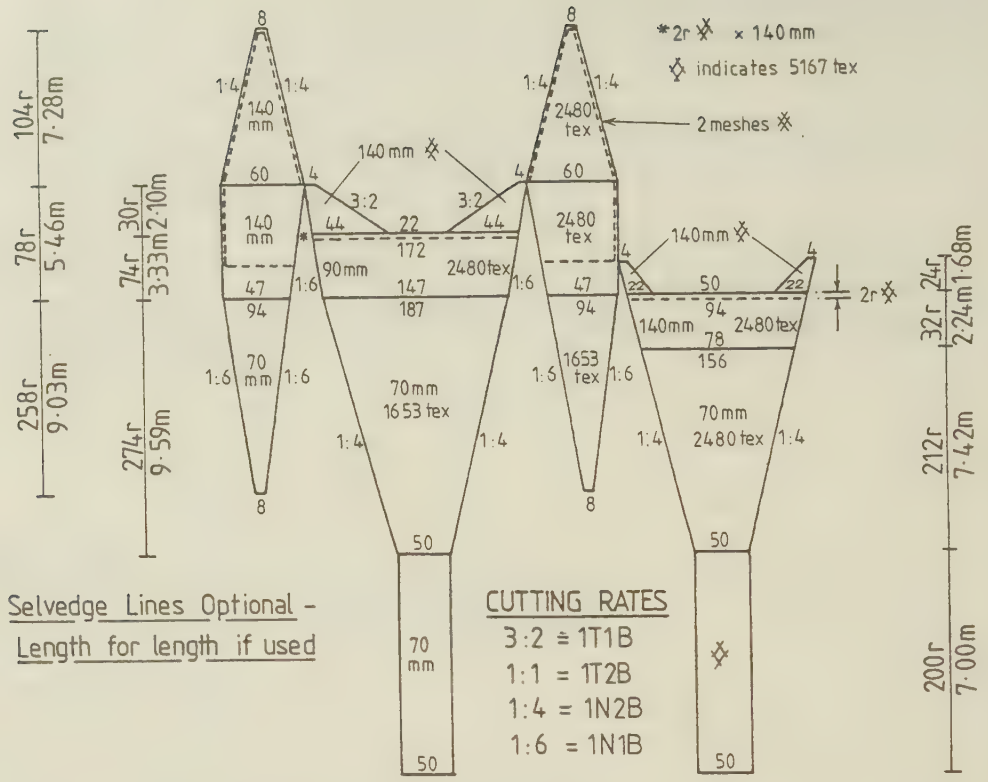


Lossie Trawl 50–100 hp

(not to scale)

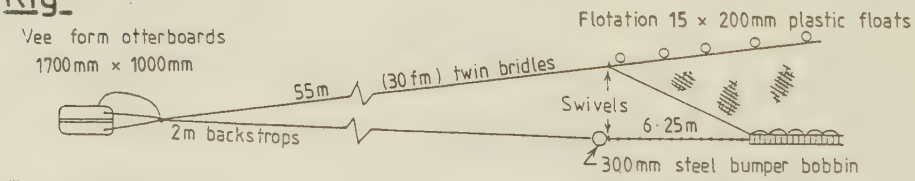
Drg Ref No - BT124R

Appendix Figure 1. **Lossie Trawl, 50-100 hp (not to scale). Net Reference No. BT 124R.**

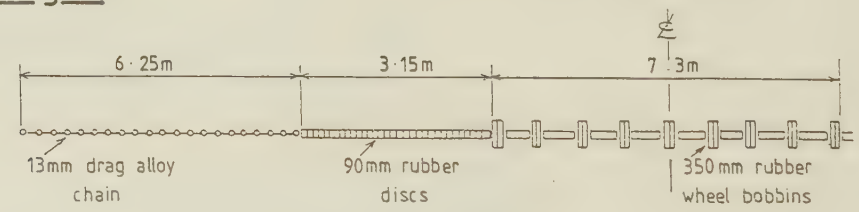


Headline - - - - 22m (6·55+3·65+1·60+3·65+6·55) × 12mm combination
Groundrope - - - 13·6m (3·15+7·30+3·15) see below
Fishing Lines - - 14·4m (3·25+2·20+3·50+2·20+3·25) × 12mm combination
Winglines - - - - 6·56m × 12mm combination
Groundchain - - 6·25m × 13mm drag alloy chain

Rig



Groundgear

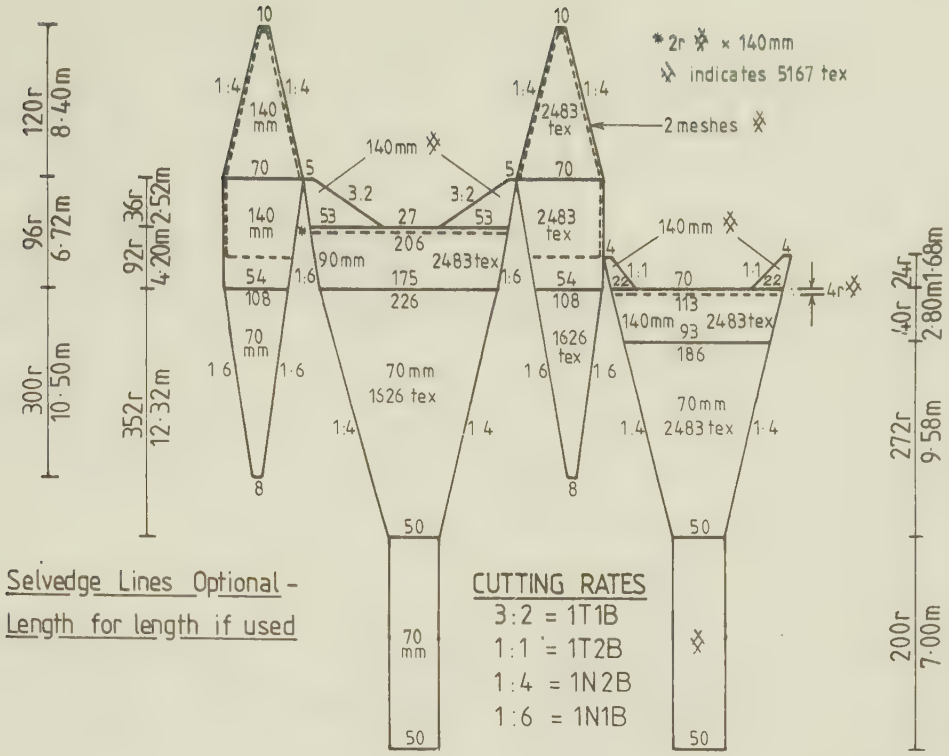


Lossie Trawl 100–200hp

(not to scale)

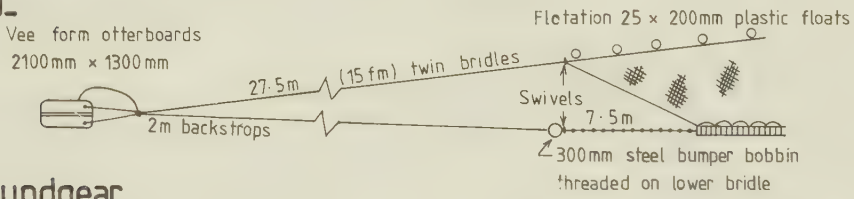
Drg Ref No - BT124Q

Appendix Figure 2. **Lossie Trawl, 100-200 hp (not to scale). Net Reference No. BT 124Q.**

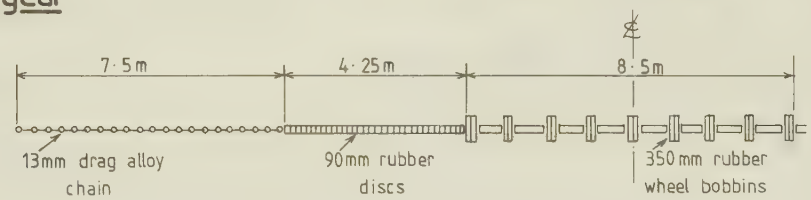


Headline ---- 26·15m (7·77+4·36+1·89+4·36+7·77) × 14mm combination
Groundrope --- 17m (4·25+8·5+4·25) see below
Fishing Lines -- 17·9m (4·5+2·0+4·9+2·0+4·5) × 14mm combination
Winglines ---- 7·77m × 14mm combination
Groundchain -- 7·5m × 13mm drag alloy chain

Rig



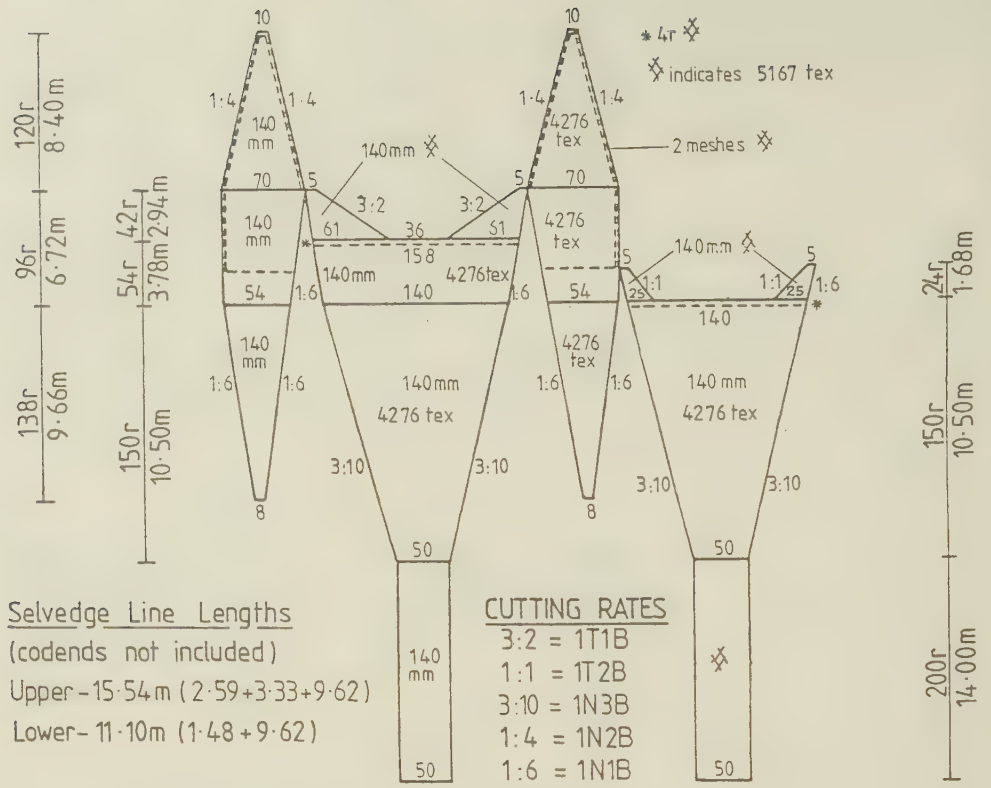
Groundgear



Lossie Trawl 250–400 hp
(not to scale)

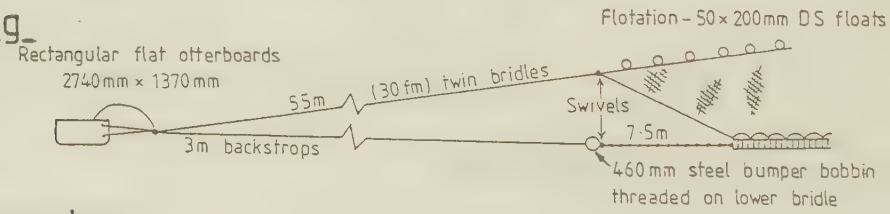
Drg Ref No-BT.124J

Appendix Figure 3. **Lossie Trawl, 250-400 hp (not to scale). Net Reference No. BT 124J.**

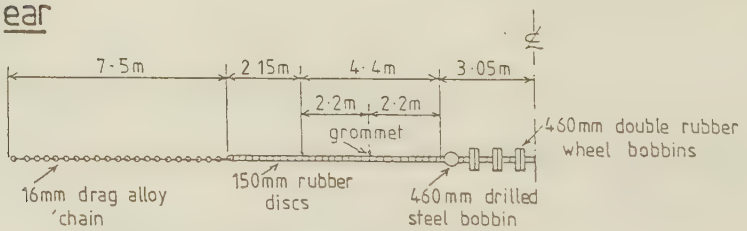


Headline ---- 28m (7·75+5·00+2·50+5·00+7·75) × 24mm combination
Groundrope --- 19·20m (6·55+6·10+6·55) see below
Fishing Lines -- 20·40m (4·70+2·30+6·40+2·30+4·70) × 20mm combination
Winglines ---- 7·75m × 20mm combination
Groundchain -- 7·5m × 16mm drag alloy chain

Rig



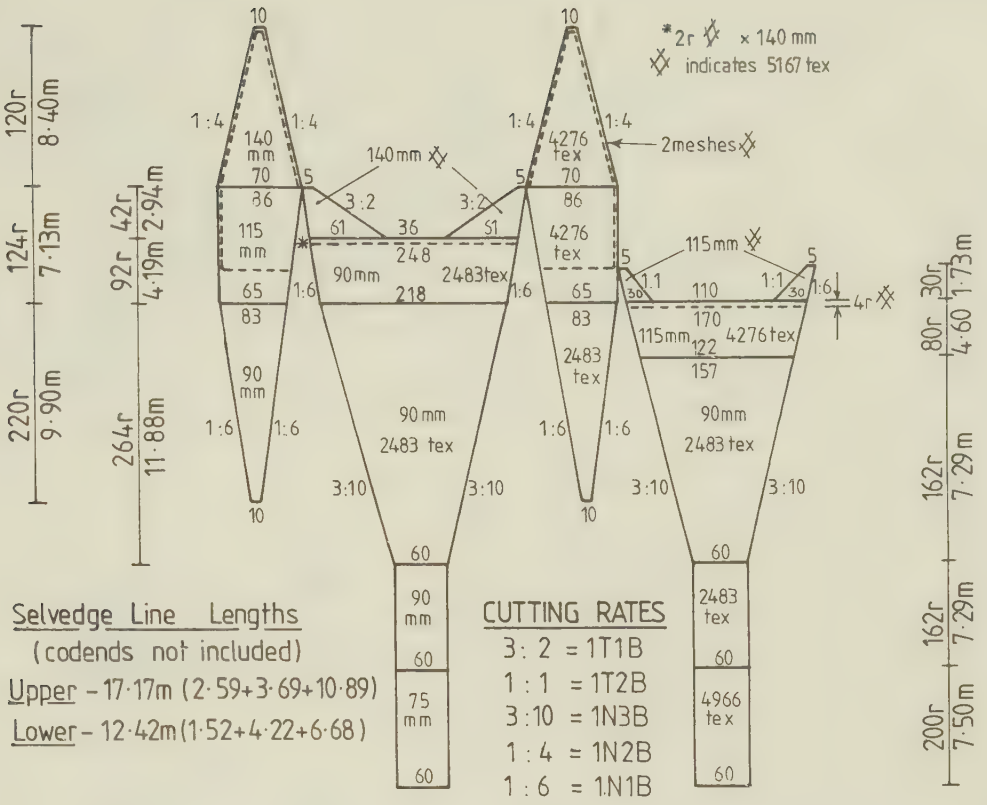
Groundgear



Faroe Trawl 600hp
(not to scale)

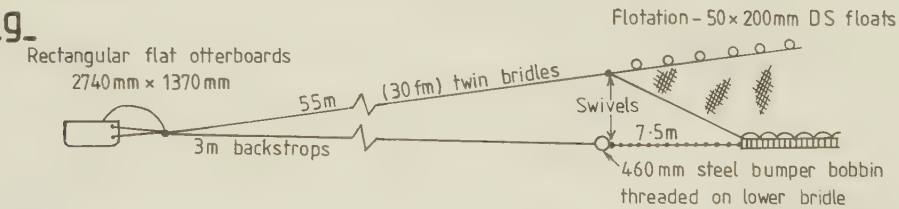
Drg Ref No - BT 130D

Appendix Figure 4. Faroe Trawl, 600 hp (not to scale). Net Reference No. BT 130D.

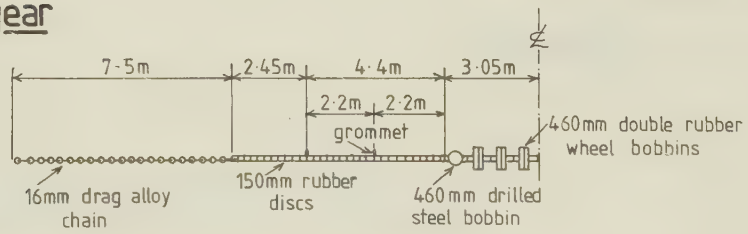


Headline ----28m (7·77+5·03+2·40+5·03+7·77) × 24mm combination
Groundrope---19·8m (6·85+6·10+6·85) see below
Fishing Lines--21m (5·02+2·28+6·4+2·28+5·02) × 20mm combination
Winglines----7·77m × 20mm combination
Groundchain--7·5m × 16mm drag alloy chain

Rig



Groundgear

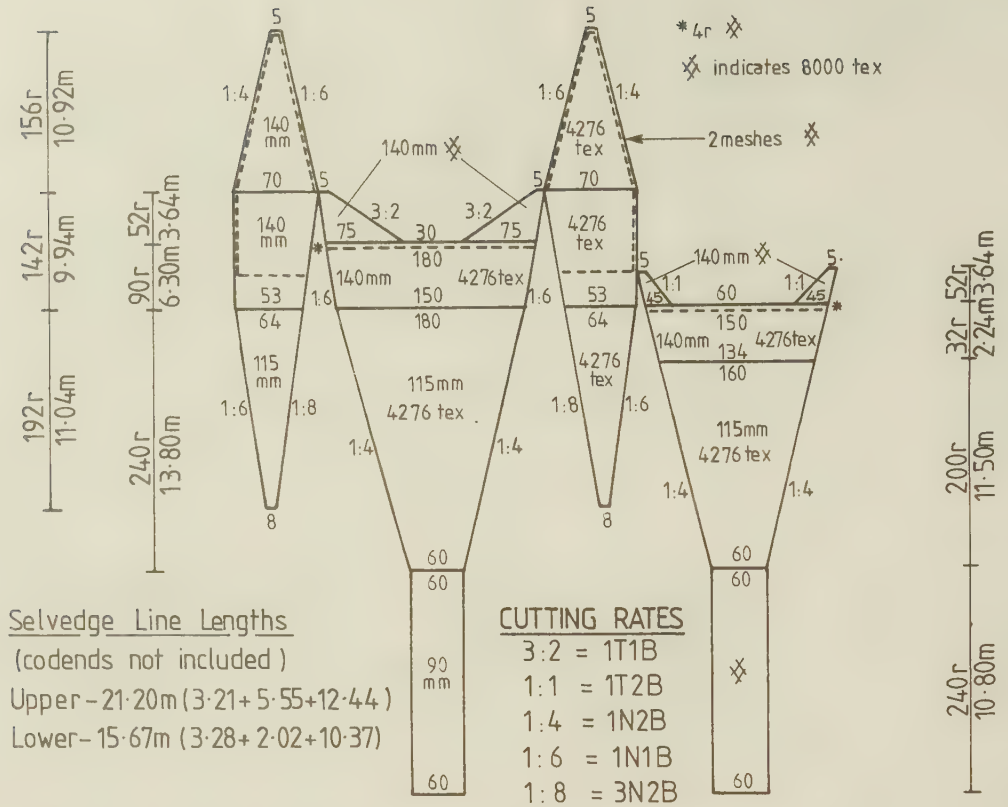


North Sea Trawl 600 hp

(not to scale)

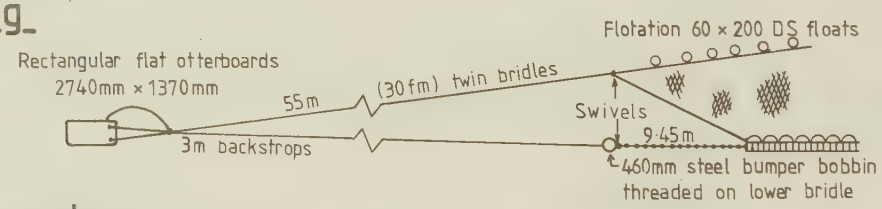
Drg Ref No - BT 130C

Appendix Figure 5. **North Sea Trawl, 600 hp (not to scale). Net Reference No. BT 130C.**

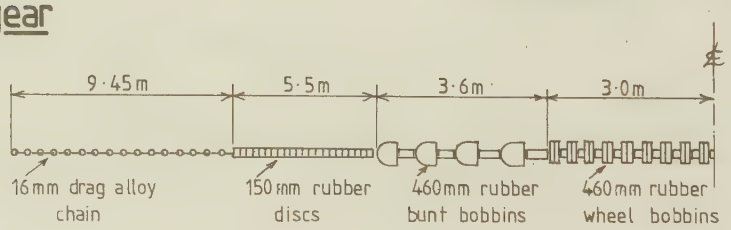


Headline ----34m (9·65+6·3+2·1+6·3+9·65) × 24mm combination
Groundrope---24·2m (5·5+3·6+6·0+3·6+5·5) see below
Fishing Lines--25m (5·6+4·8+4·2+4·8+5·6) × 20mm combination
Winglines----9·84m × 20mm combination
Groundchain--9·45m × 16mm drag alloy chain

Rig



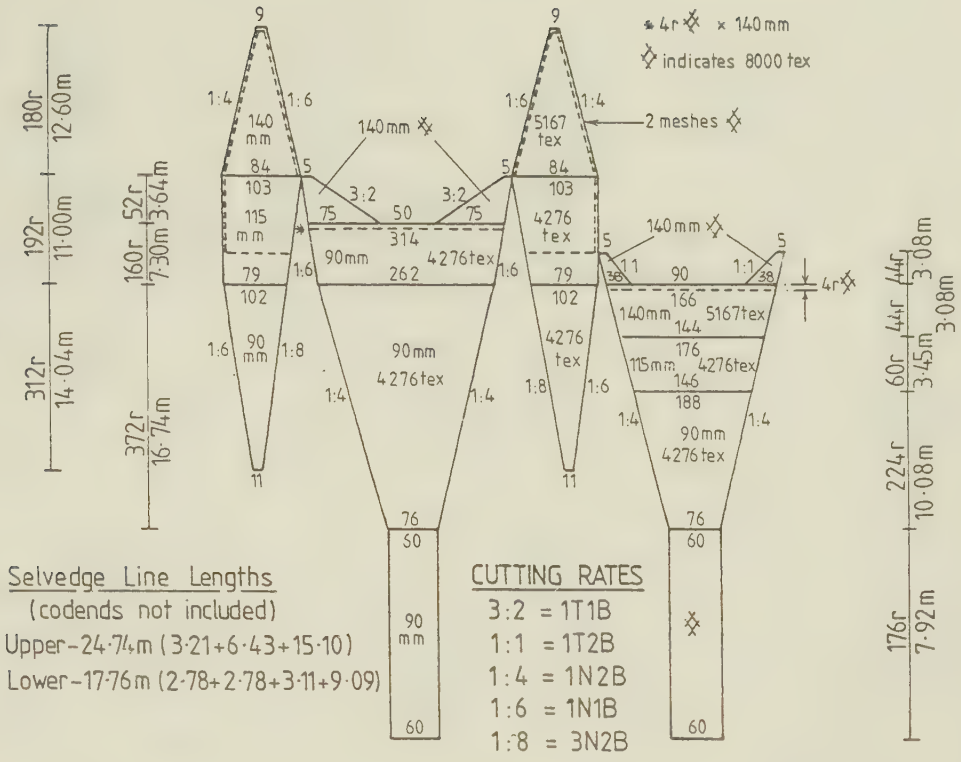
Groundgear



North Sea Trawl 800 hp
(not to scale)

Drg Ref No – BT130B

Appendix Figure 6. **North Sea Trawl, 800 hp (not to scale). Net Reference No. BT 130B.**



Headline ---- 38·30m (11·10+6·30+3·50+6·30+11·10) × 14mm served wire

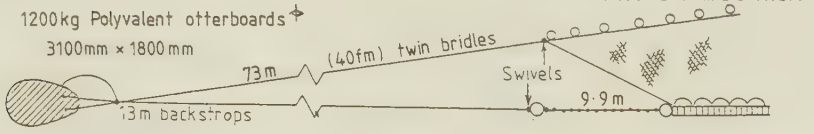
Groundrope--- 26·90m (6·70+3·70+6·10+3·70+6·70) see below

Fishing Lines-- 28·20m (6·90+4·00+6·40+4·00+6·90) × 20mm combination

Winglines---- 11·35m × 20mm combination

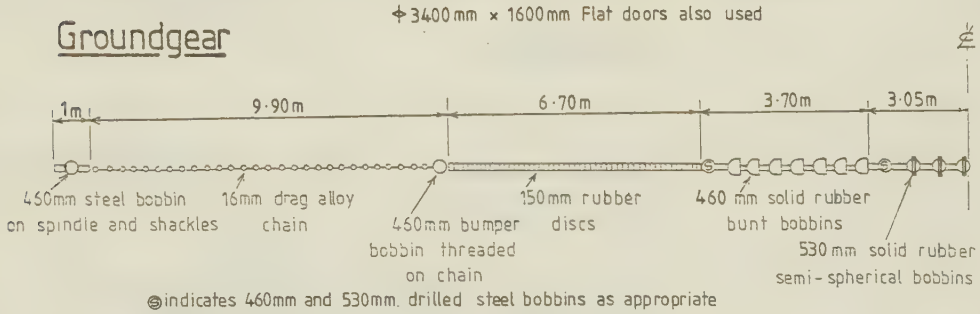
Groundchain-- 10·90m overall (including bobbin on spindle and 9·9m × 16mm drag alloy chain)

Rig



3400mm × 1600mm Flat doors also used

Groundgear



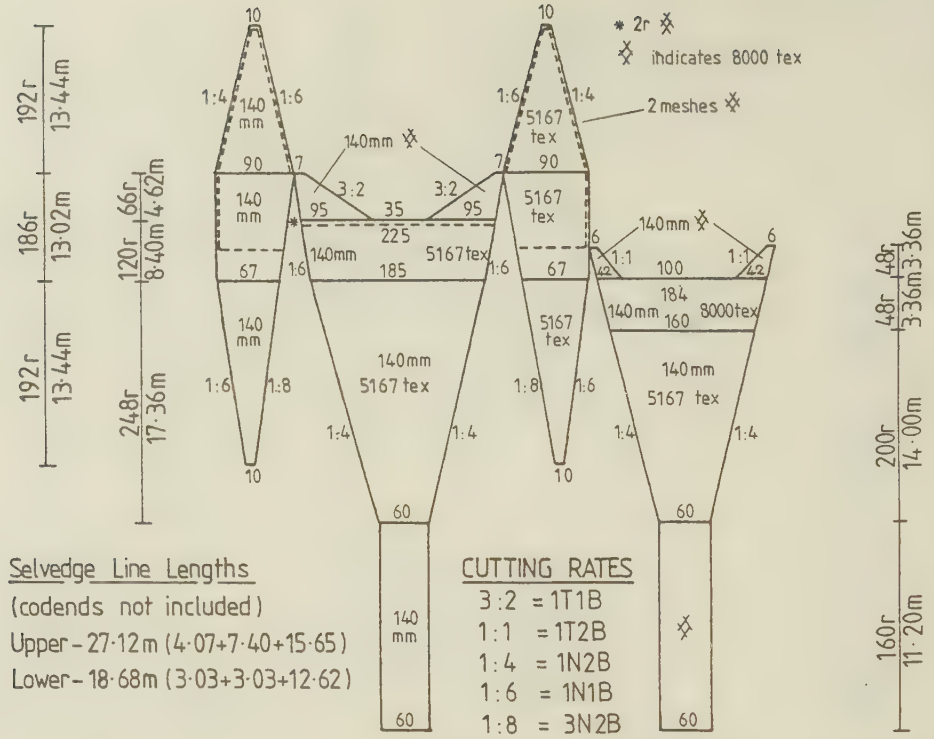
indicates 460mm and 530mm. drilled steel bobbins as appropriate

North Sea Trawl 1000–1500 hp

(not to scale)

Drg Ref No - BT 130E

Appendix Figure 7. **North Sea Trawl, 1000-1500 hp (not to scale). Net Reference No. BT 130E.**



Headline ----42·13m (11·84+8·0+2·45+8·00+11·84) × 14mm served wire

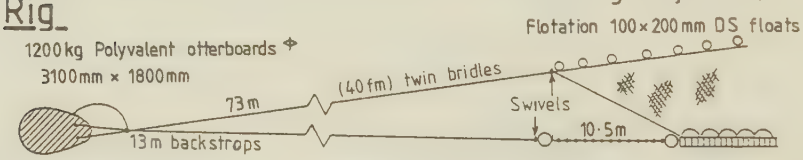
Groundrope ---30·60m (8·00+4·25+6·10+4·25+8·00) see below

Fishing Lines-- 32·30m (8·36+4·44+6·40+4·44+8·36) × 20mm combination

Winglines ----12·1m × 20mm combination

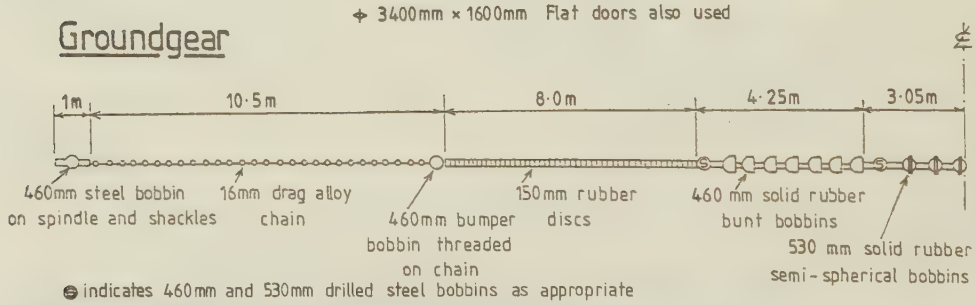
Groundchain -- 11·5m overall (including bobbin on spindle and 10·5m × 16mm drag alloy chain)

Rig



✣ 3400mm × 1600mm Flat doors also used

Groundgear



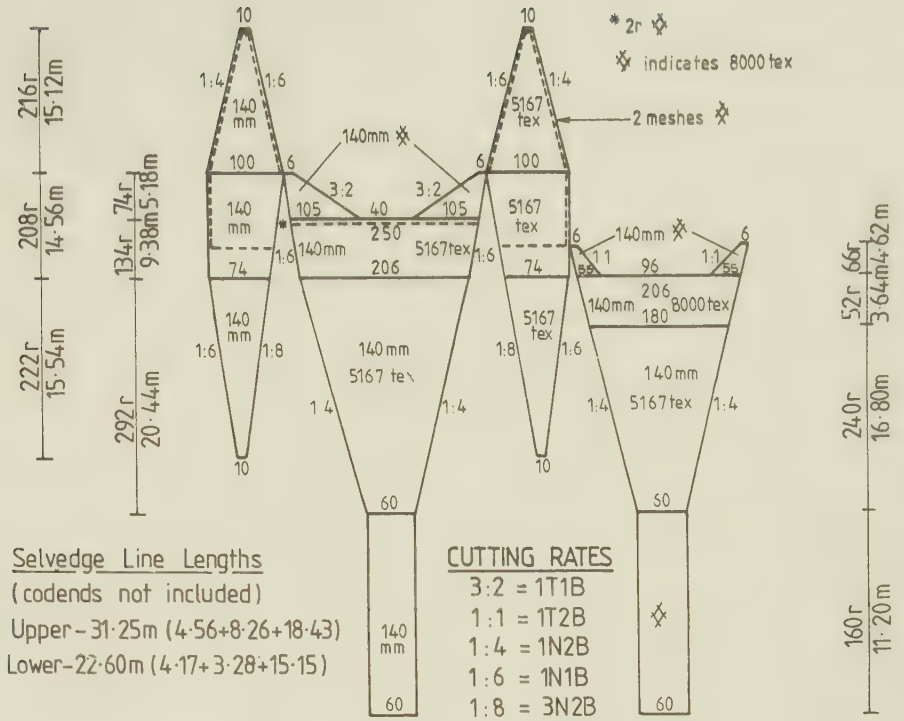
● indicates 460mm and 530mm drilled steel bobbins as appropriate

White Sea Trawl 1000–1500 hp

(not to scale)

Drg Ref No - BT 134

Appendix Figure 8. White Sea Trawl, 1000-1500 hp (not to scale). Net Reference No. BT 134.



Headline - - - - 47·4m (13·3+9·0+2·8+9·0+13·3) × 14mm served wire

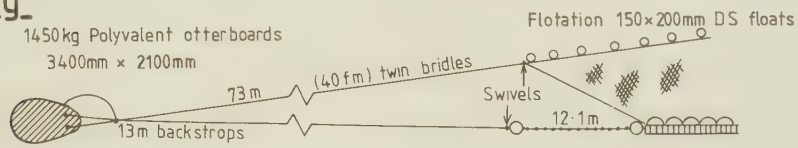
Groundrope - - - 34·6m (8·3+5·8+6·4+5·8+8·3) see below

Fishing Lines - - 36·1m (8·6+6·1+6·7+6·1+8·6) × 20mm combination

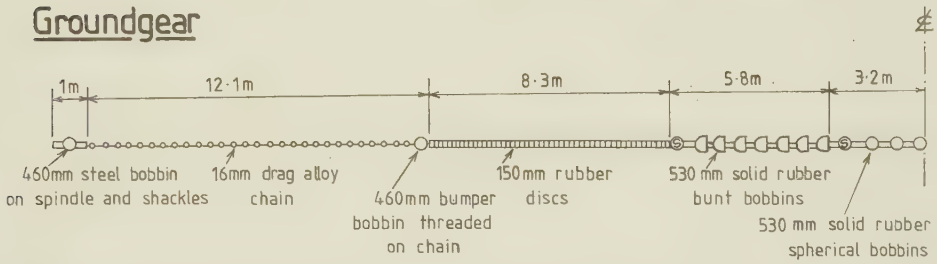
Winglines - - - - 13·6m × 20mm combination

Groundchain - - 13·1m overall (including bobbin on spindle and 12·1m × 16mm drag alloy chain)

Rig



Groundgear



White Sea Trawl 2000 hp
(not to scale)

Drg Ref No - BT 135

Appendix Figure 9. **White Sea Trawl, 2000 hp (not to scale). Net Reference No. BT 135.**

PREVIOUS SCOTTISH FISHERIES INFORMATION PAMPHLETS

1977

No. 1. An introduction to Commercial Fishing Gear and Methods Used in Scotland.
By E.S. Strange, 34pp.

1978

No. 2. A Guide to the Preparation of Net Drawings.
By E.S. Strange, 18pp.

1981

No. 3. A Method for Testing the Effectiveness of Different Fishing Baits in the Sea.
By A.D.F. Johnstone and A.D. Hawkins, 7pp.

No. 4. Experiments on Suspended Cultivation of Mussels in Scotland.
By James Mason and J. Drinkwater, 15pp.

No. 5. The Calculation of the Twine Area of a Trawl Net.
By R.S.T. Ferro, 6pp.

No. 6. Choosing the Size of Suberkrub Trawl Board to Suit a Pelagic-Type Four-Panel Trawl.
By R.S.T. Ferro, 5pp.

1982

No. 1 (Second Edition, Revised). An Introduction to Commercial Fishing Gear and Methods used in Scotland.
By E.S. Strange, 35pp.

No. 7. The Norway Lobster.
By F.G. Howard, 15pp.

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